

CLAIMS

1. A tensioning apparatus comprising:
 - a shank member;
 - an annular member comprising an opening sized to receive the shank member with an interference fit;
 - a fluid passageway for delivering a pressure between the shank member and the annular member for expanding the opening to relax the interference fit;
 - a tensioner responsive to a pressure to apply a force to tension the shank member;wherein a first pressure is required in the fluid passageway to relax the interference fit when the shank member is relaxed, and a second pressure lower than the first pressure is required in the fluid passageway to relax the interference fit when the shank member is tensioned; and wherein
 - the tensioner is selected to provide a desired tensioning force to the shank member at the second pressure so that a single pressure source may be used to provide pressure to the fluid passageway and to the tensioner to achieve a desired pre-load in the shank member.
2. The tensioning apparatus of claim 1, further comprising:
 - a pump;
 - a first valve connected between the pump and the fluid passageway; and
 - a second valve connected between the pump and the tensioner.
3. The tensioning apparatus of claim 1, wherein the tensioner further comprises:
 - a piston disposed within a cylinder to define a pressure chamber;
 - a first of the piston and cylinder connected to the shank member for applying the force to tension the shank member and a second of the piston and cylinder connected to the annular member for applying a reaction force through the annular member.
4. The tensioning apparatus of claim 3, further comprising:

a pump;

a first valve connected between the pump and the fluid passageway; and

a second valve connected between the pump and the pressure chamber.

5. The tensioning apparatus of claim 4, wherein the pump, first valve and second valve comprise a pressure supply, and further comprising a controller for remotely operating the pressure supply.

6. A tensioning apparatus comprising:

a shank member;

an annular member comprising an opening sized to receive the shank member with an interference fit;

a fluid passageway for delivering a pressure between the shank member and the annular member for expanding the opening to relax the interference fit;

a tensioner responsive to a pressure to apply a force to tension the shank member; and

a single pressure source fluidly connected to the fluid passageway and to the tensioner for tensioning the shank member with the interference fit relaxed.

7. The tensioning apparatus of claim 6, wherein the single pressure source further comprises:

a pump;

a first valve connected between the pump and the fluid passageway; and

a second valve connected between the pump and the tensioner.

8. The tensioning apparatus of claim 6, wherein the tensioner further comprises:

a piston disposed within a cylinder to define a pressure chamber;

a first of the piston and cylinder connected to the shank member for applying the force to tension the shank member and a second of the piston and cylinder connected to the annular member for applying a reaction force through the annular member.

9. A tensioning apparatus comprising:
a shank member;
an annular member comprising an opening sized to receive the shank member with an interference fit;
a means for expanding the opening to relax the interference fit; and
a means for applying a tensile force to the shank member and a reaction force equal in magnitude and opposed in direction to the tensile force to the annular member.
10. The tensioning apparatus of claim 9, further comprising a means for providing a single pressure to both the means for expanding and the means for applying a tensile force.
11. The tensioning apparatus of claim 10, wherein the means for providing a single pressure comprises:
a pump;
a first valve connected between the pump and the means for expanding; and
a second valve connected between the pump and the means for applying a tensile force.
12. The tensioning apparatus of claim 9, wherein the means for expanding further comprises:
a hole formed through the annular member from an outside surface to an inside surface defining the opening; and
a groove formed along the inside surface and in fluid communication with the hole.
13. The tensioning apparatus of claim 12, wherein the means for expanding further comprises:
a plurality of circumferential grooves formed along the inside surface; and
at least one axial groove formed along the inside surface interconnecting the circumferential grooves.

14. The tensioning apparatus of claim 9, wherein the means for expanding further comprises:

a hole formed along an axis of the shank member; and
a circumferential groove formed on an outside surface of the shank member in fluid communication with the hole.

15. A method of tensioning a shank member comprising:
providing an annular member having an opening receiving a shank member with an interference fit there between;
expanding the opening with a first pressure to relax the interference fit;
applying a second pressure to a tensioner to tension the shank member;
releasing the first pressure to reestablish the interference fit to retain the shank member tension when the second pressure is relaxed.

16. The method of claim 15, further comprising:
selecting the tensioner to apply a desired tension to the shank member at the first pressure; and
providing the first pressure and the second pressure from a single pressure source.

17. The method of claim 15, further comprising installing the tensioner to apply a tension force against the shank member and to apply a reaction force equal in magnitude and opposite in direction to the tension force to the annular member.

18. The method of claim 15, further comprising releasing the shank member tension by applying a third pressure to re-expand the opening to again relax the interference fit.